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Research Report

REDEFINITION OF THE MACULA NEGLECTA IN MAMMALS*

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SUMMARY PAGE

THE PROBLEM

Investigators differ with respect to the terminology regarding and the frequency with which rudimentary sensory end organs are found in the inferior (or posterior) utricular sinus of different mammalian species.

FINDINGS

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The rudimentary vestibular sensory end organ at the junctions of the utricle and semicircular canals was investigated in 70 mammalian ears, including those of man.

The papillary or smooth epithelial thickening at the junction of the posterior crus of the lateral semicircular canal and the inferior utricular sinus, which has been called macula neglecta by many previous investigators, was observed in almost all of the human and dog specimens and in 25 per cent of the squirrel monkeys. The term "epithelial mound of latero-posterior utricular fold" is recommended.

In the cat and dog ears examined, but in none of the other mammals, the epithelial structure on the anterior medial wall of the inferior utricular sinus exhibited in almost all instances a stroma, blood supply, nerve supply, and specialized sensory epithelium. For this reason, the term "sensura neglecta" is suggested as an adequate one.

Author

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INTRODUCTION

A small sensory end organ, deep in the inferior utricular sinus, was first described by Retzius (7) in fish and reptiles and termed the macula acoustica neglecta. Sakai (8) and Stütz (9), studying human serial sections, observed an epithelial mound on the roof and floor of the utricle near the posterior canal ampulla in almost all of their cases. This structure was termed the (rudimentary) macula neglecta. Benjamins (1) described this structure at several different locations in fish, amphibians, reptiles, birds, and mammals and termed it the crista neglecta sive quarta. He also described an epithelial mound on the utricular wall in the mouse and some reptiles. de Burlet (2,3) examined mammals and amphibians and used the term papilla neglecta for this epithelial structure.

In 1961, Gacek (6) examined the cat, lion, dog, pigeon, mouse, chinchilla, guinea pig, monkey, and man. He pointed out that the crista neglecta (1) is an adequate term for the rudimentary sensory end organ on the floor of the utricle, and the epithelial thickening on the utricular wall should not be called the macula neglecta.

Thus confusion exists not only in regard to the terminology but also as to location and structural differences. Most previous investigators described the locations very grossly. Since the inferior utricular sinus is a structurally congested area, the locations should be studied in more detail.

The purpose of the present investigation is to clarify the exact locations and the structural differences and to give these different structures adequate terms.

PROCEDURE

Sixteen normal human ears (including six fetal ears), twenty squirrel monkey ears, twenty-four cat ears, eight guinea pig ears, and two dog ears were used for this investigation.

All temporal bone specimens were fixed, decalcified, dehydrated, embedded in celloidin, serially sectioned in horizontal plane at 20 microns, and stained in Hematoxylin-Eosin or Hematoxylin-Phloxin.

The areas of the inner ear of each mammal which were examined are shown in Figure 1* and have been termed areas A, B, C, and D. These areas may be defined as follows:

Area A: The junction between the horizontal semicircular canal ampulla and the utricle, and the immediately adjacent area.

Area B: The junction between crus commune and the utricle.

*In order not to break the continuity of the text, all figures appear at the end of the report.

Area C: The junction between the posterior crus of the horizontal semicircular canal and the inferior utricular sinus.

Area D: The junction between the inferior utricular sinus and the posterior semicircular canal ampulla.

RESULTS

The incidence at which an epithelial mound was found in areas A, B, and C and a sensory end organ type structure disclosed in area D is listed in Table I.

At the point defined as area A, a slight epithelial thickening was observed in two of sixteen humans, two of twenty squirrel monkeys, and two of twenty-four cats. This junction, however, is so close to both the superior and horizontal semicircular canal cristae that this epithelial mound may possibly be an extension of the transitional epithelium of the crista ampullaris or the planum semilunatum. No such structure was found in the eight guinea pigs or the two dog ears examined.

A papillary epithelial thickening was observed in two of sixteen human ears at area B. In three other human specimens it was observed on the utricular wall about 200 microns from this junction (Figure 2). In squirrel monkeys, cats, guinea pigs, and dogs no significant structure was observed in this region.

At area C, a papillary epithelial thickening was observed in fourteen of sixteen human temporal bones (Figures 3-7). In some of these instances, especially in fetal specimens, this structure was found to be located within the lateral semicircular canal, as shown in Figures 6 and 7. It is evident, therefore, that this epithelial thickening is anatomically distinct from that described below in area D. In the two other human ears, an epithelial fold without papillary thickening was found in one, while no fold was present in the other.

These papillary structures contained a layer of cuboidal or columnar cells and thickened subepithelial connective tissue, usually with a rich vascular supply. No sensory hair cells were found in this area. There were pigmented granules throughout this structure. Neither the present nor any previous investigation has been able to demonstrate any nerve supply to this area.

Of the twenty squirrel monkey specimens, four showed the papillary epithelial mound (Figure 8) while one had smooth epithelial thickening (Figure 9). Only two of twenty-four cat ears exhibited epithelial thickening in this region. The two dog ears both showed the papillary epithelial thickening (Figure 10), but none of the guinea pigs revealed the structure at this area.

Table I

Incidence of Findings in Investigated Areas* of Mammalian Ears

Mammal	Number of Specimens	Areas					
		A		B		C	
		No.	%	No.	%	No.	%
Human	16	0	0	2	13	14	88
Squirrel Monkey	20	0	0	0	0	5	25
Cat	24	0	0	0	0	2	8
Dog	2	0	0	0	0	2	100
Guinea Pig	8	0	0	0	0	0	0

*Areas A, B, C, and D are illustrated in Figure 1.

In the horizontal sections of temporal bones from some humans, cats, and dogs, the floor of the inferior utricular sinus frequently appears in the same plane as the crista of the posterior semicircular canal. In the present study of area D, one human ear demonstrated minimal epithelial thickening at this junction, while a second, with no known otological disease, showed bleb formation in the posterior canal ampulla (Figure 11). The other fourteen human ears and the twenty squirrel monkey ears showed no significant structure in this area.

On the other hand, sensory end organ like structures were found on the anterior medial wall of the inferior utricular sinus in all of the twenty-four cats. Eighteen of these twenty-four showed accessory cristae, occasionally with a cupula-like substance (Figure 12) and with transitional areas on both sides. In the remaining six cat ears, macula-like structures were observed. In almost all cases, this structure was supplied with blood vessels and in some, nerve tissue could be identified. These morphological features indicate that this structure can be termed a sensory end organ.

In eight guinea pig ears there were no such structures in this area. A crista-like structure was observed in two dog ears on the anterior medial wall of the inferior utricular sinus (Figures 13 and 14).

DISCUSSION

Two common sites in man of the papillary epithelial mound as described by Sakai (8) and Stütz (9) were: 1) near, and usually above, the crus commune-utricular junction, and 2) in the lateral posterior part of the inferior utricular sinus, near the lateral semicircular canal-utricular junction. Both of these investigators found the structures in almost all of their human cases and both termed this structure the macula neglecta. In several textbooks (4,5,10,11) there are similar illustrations and microphotographs which also show this structure at the above-mentioned locations.

In the present study this structure was observed at area C, along the epithelial fold between the posterior crus of the horizontal semicircular canal and utricle (opposite the utriculo-endolymphatic fold), in 88 per cent of the human cases. These papillary structures appeared at the top of the above-mentioned fold or fairly frequently within the horizontal semicircular canal (Figures 6 and 7), especially in the fetus. This area of the vestibule is possibly innervated by either the saccular nerve or posterior ampullar nerve, both of which are terminal divisions of the inferior vestibular nerve. Since the structure at area C is located on the lateral side of the inferior utricular sinus, and the two nerves course through the bone on the medial side of this sinus, any nerve innervation to the structure must go through the limited area of the membranous labyrinth. The review of the serial sections of this area revealed no nerve supply to the structure at area C. Likewise, since this epithelial thickening is not a sensory end organ structure, we concur with Gacek (6) that this epithelial thickening should not be termed the macula neglecta.

Specialized structures were found only in the cat and the dog upon study of area D. In these species, the structure is consistently located on the anterior medial wall of the inferior utricular sinus, near the junction of the posterior semicircular canal ampulla. In almost all cats, this epithelial structure exhibited a stroma, blood supply, nerve supply, and sensory epithelium. This has been referred to in the literature as both crista neglecta and macula neglecta. In view of the fact that both types of structures were observed in the cat, it would appear that neither would be adequate. For this reason, it is proposed that this sensory end organ structure, when complete with all of its components, should be termed the "sensura neglecta."

Quite evidently, this sensory end organ structure is not analogous to the smooth or papillary epithelial mound described at the other areas. The epithelial mound at area C, in contrast, should be termed the "epithelial mound of the latero-posterior utricular fold."

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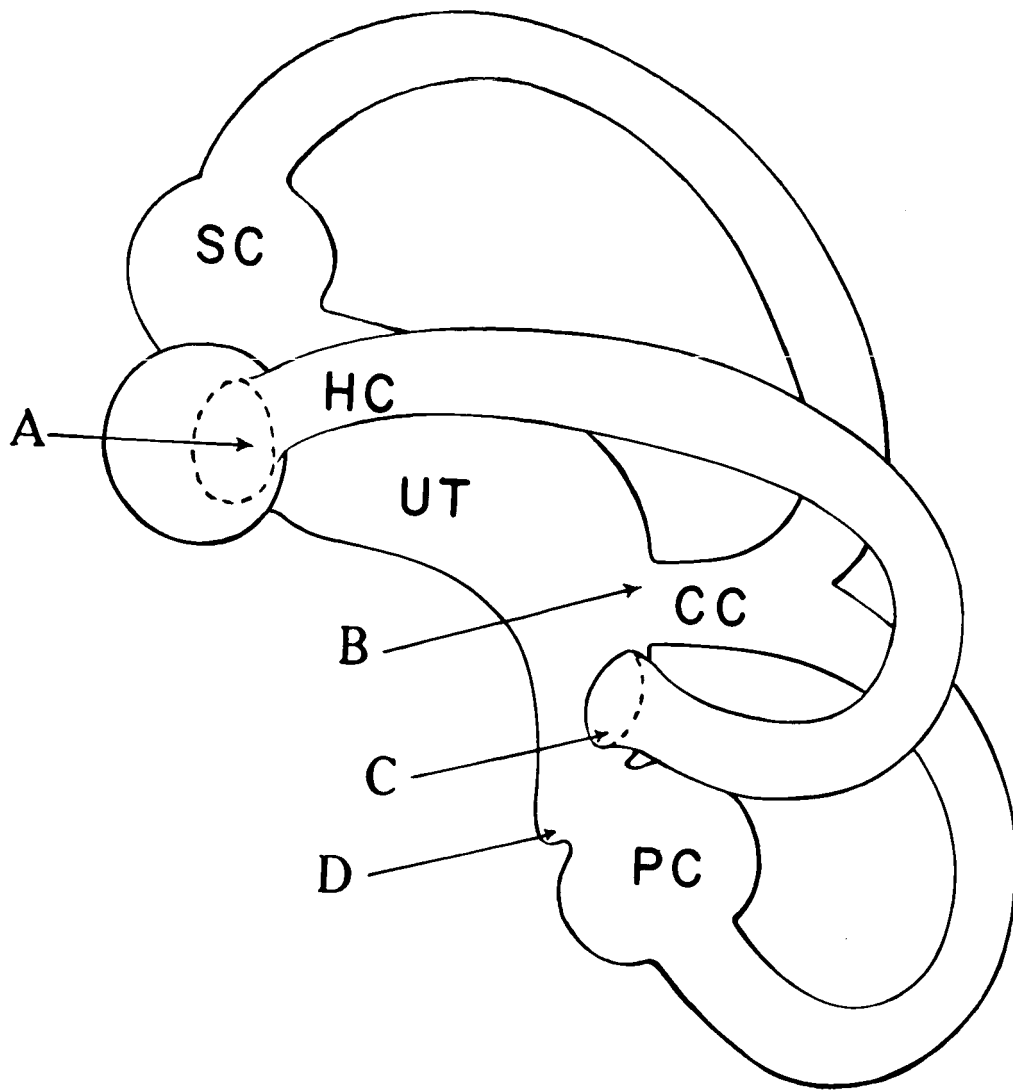


Figure 1

The lateral view schemata of the left inner ear, showing four objected areas (A,B,C, and D) in present investigation.

- SC: Superior semicircular canal ampulla.
- HC: Horizontal semicircular canal.
- UT: Utricle,
- CC: Common Crus,
- PC: Posterior semicircular canal ampulla.

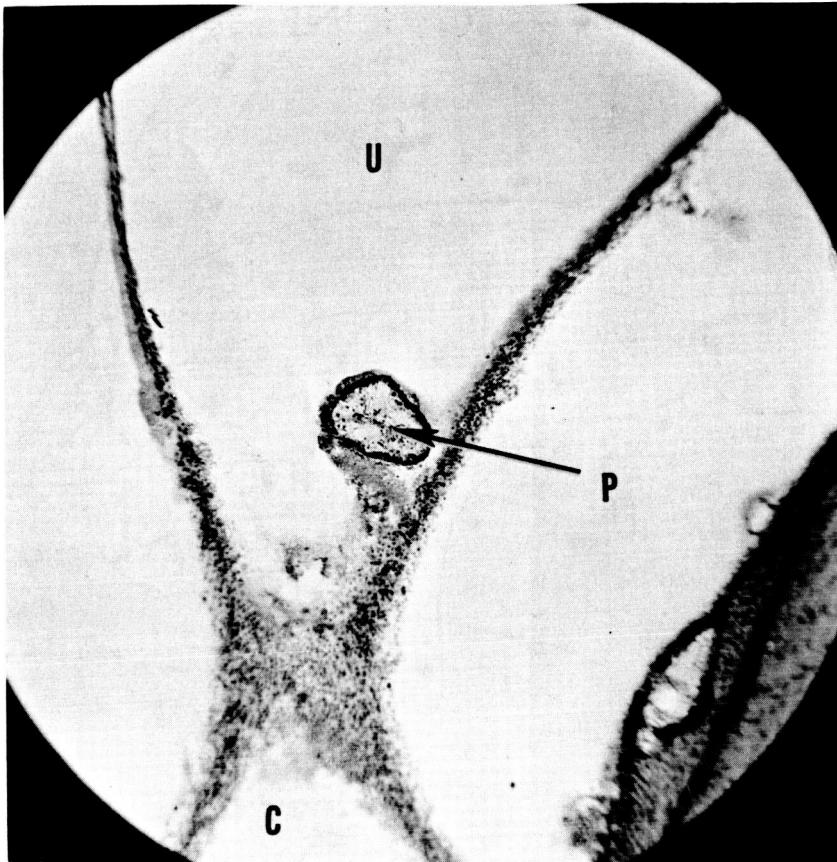


Figure 2

Papillary structure (P) near the junction of utricle (U) and common crus (C), which is sectioned horizontally. (human adult) 150X

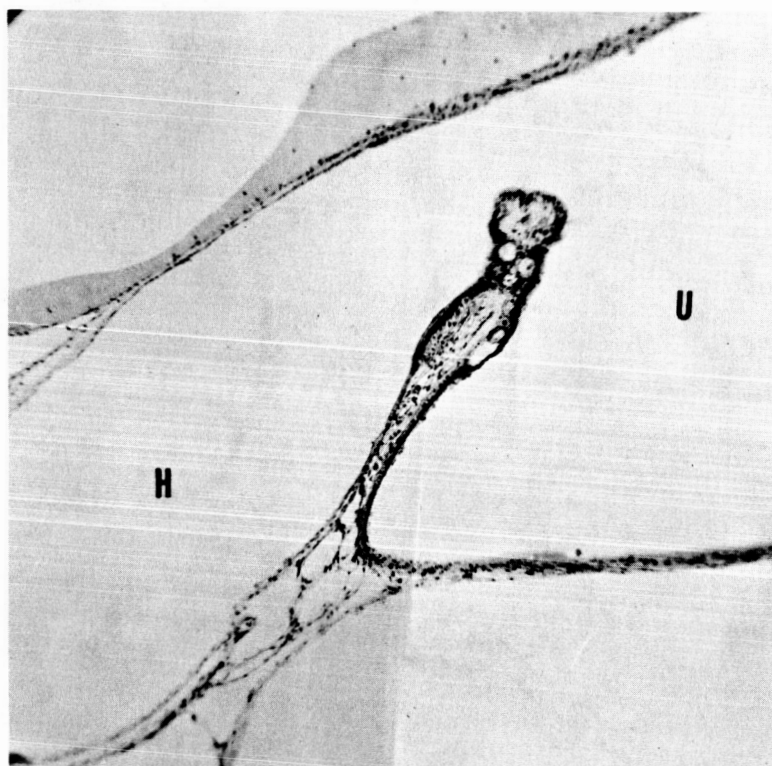


Figure 3

Papillary epithelial mound at the junction of utricle (U) and posterior crus of horizontal semicircular canal (H). (human adult) 90X

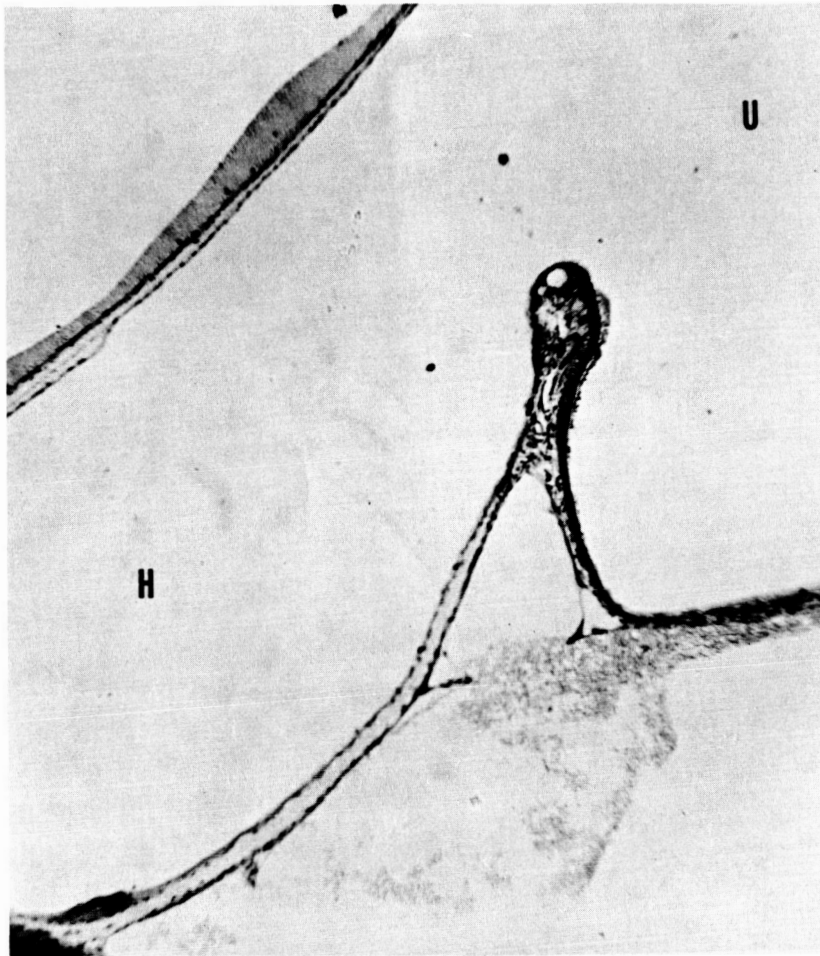


Figure 4

Epithelial mound at the junction of utricle (U) and posterior crus of horizontal semicircular canal (H). (human adult) 100X

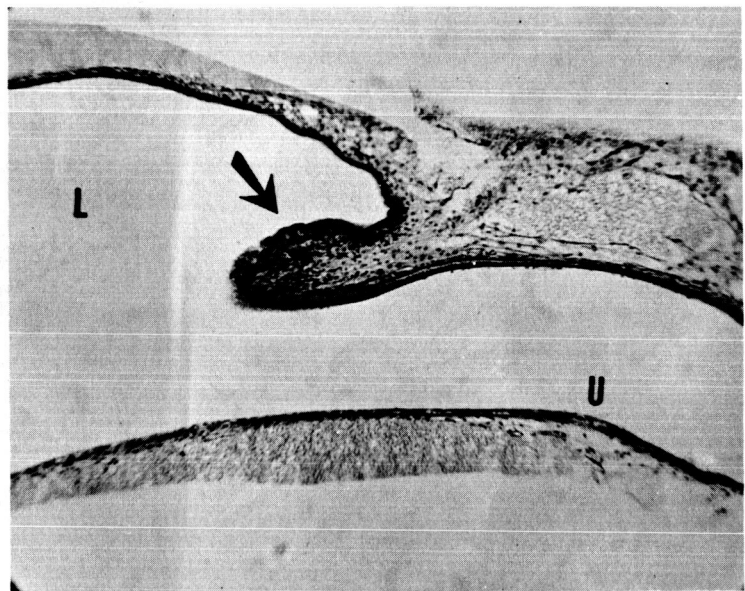
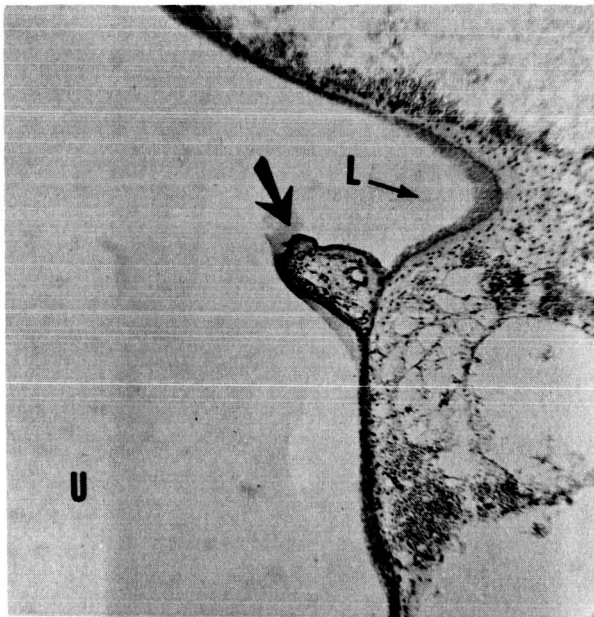


Figure 5

Papillary epithelial mound at the junction of utricle (U) and posterior crus of lateral semicircular canal (L) from two human fetal ears. 75X

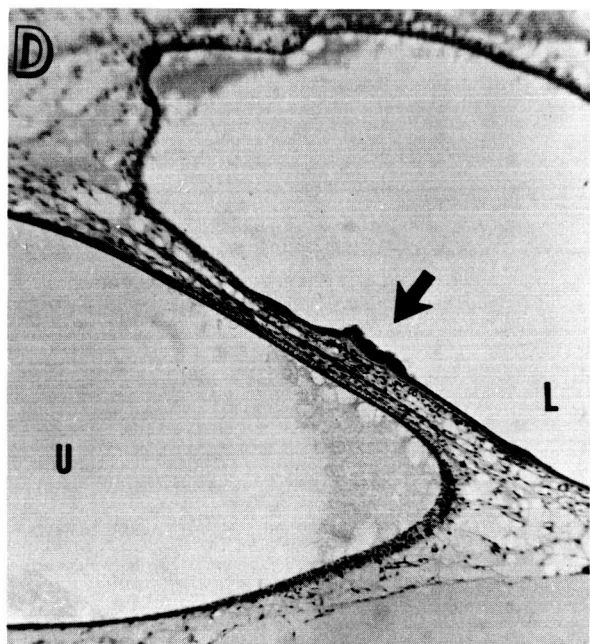
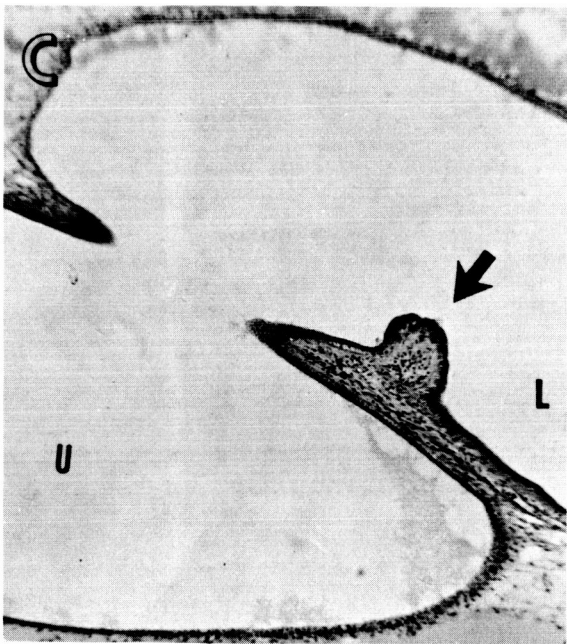
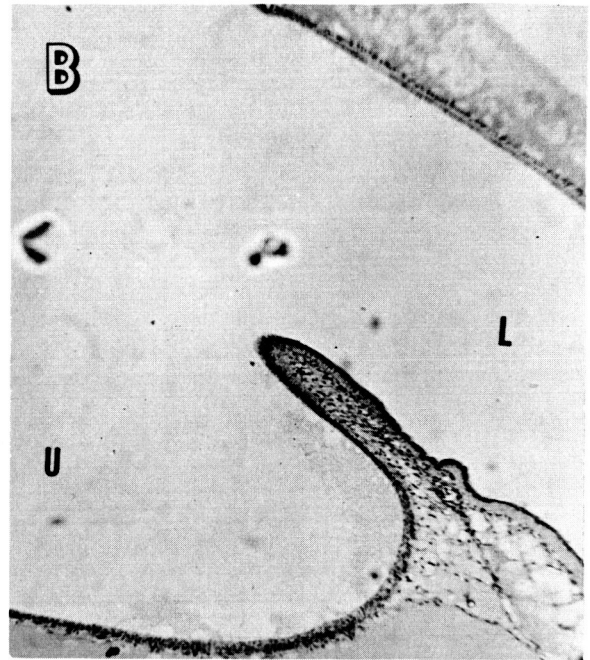
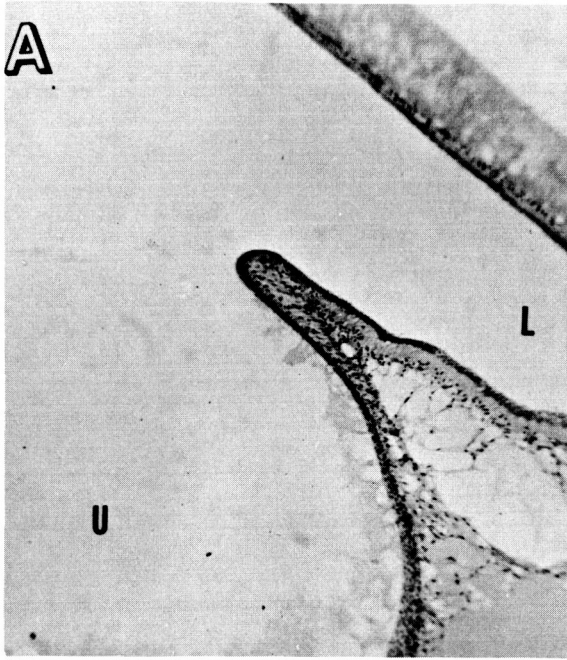


Figure 6 A-D

A series of microphotographs demonstrating the papillary epithelial mound (broad arrow) located in the lateral semicircular canal (L) at the utricular junction (U). Horizontal sections. Celloidin embedding and hematoxylin-eosin staining. 200 microns interval. (human fetus) 75X

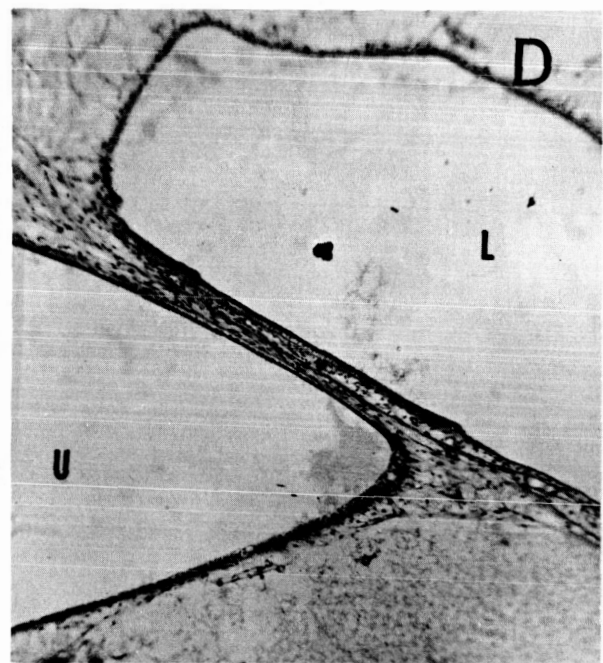
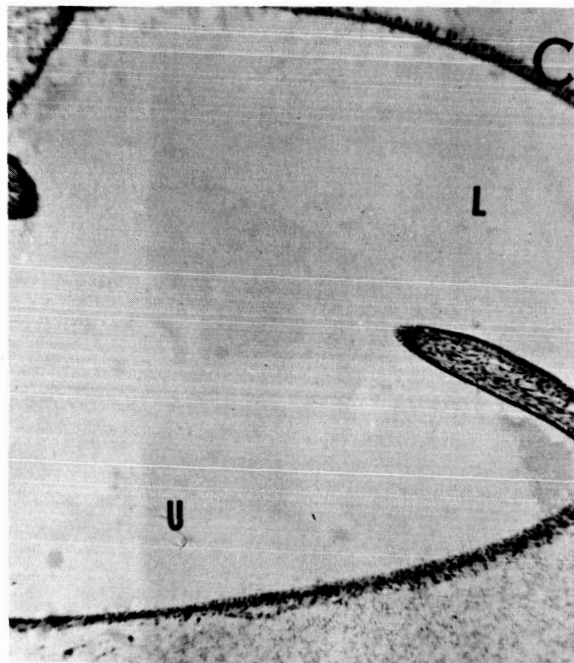
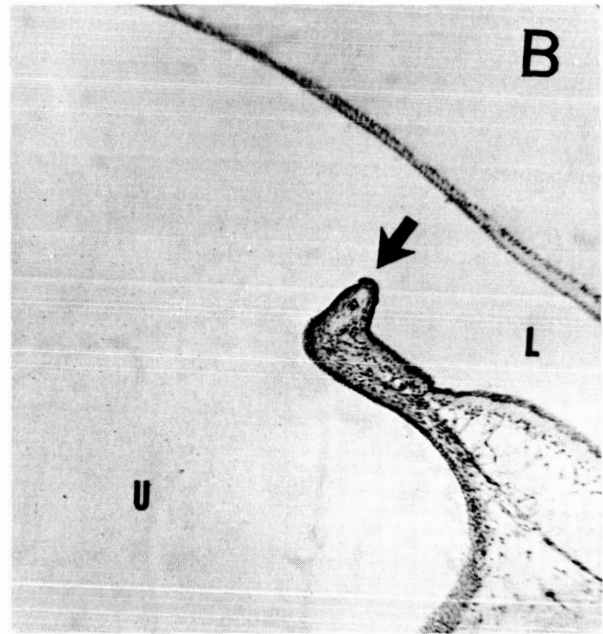
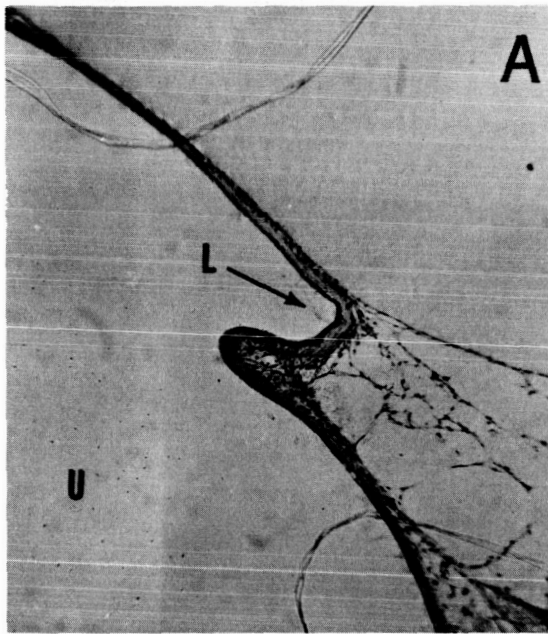


Figure 7 A-D

Another series shows the papillary epithelial mound (broad arrow) located in the lateral semicircular canal (L), at the utricular junction (U). Horizontal sections. 200 microns interval. (human fetus) 75X

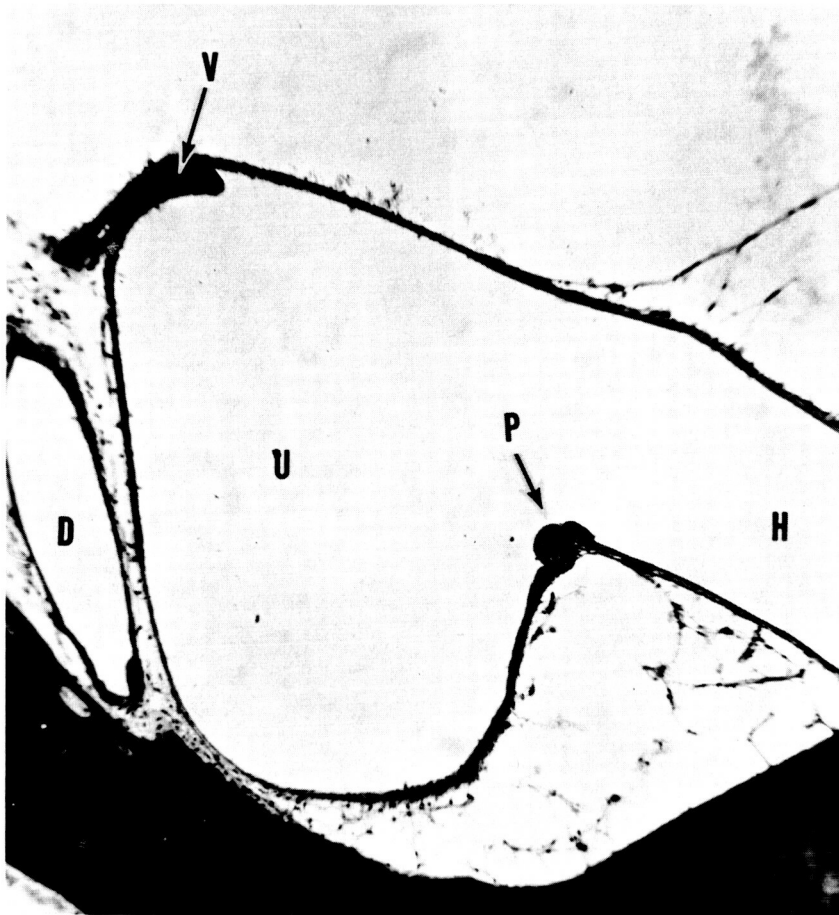


Figure 8

Showing papillary epithelial mound (P) at the junction of utricle (U) and horizontal semicircular canal (H) in a squirrel monkey. 100X

- V: Utriculo-endolymphatic valve.
D: Utricular duct (possibly a part of endolymphatic duct),

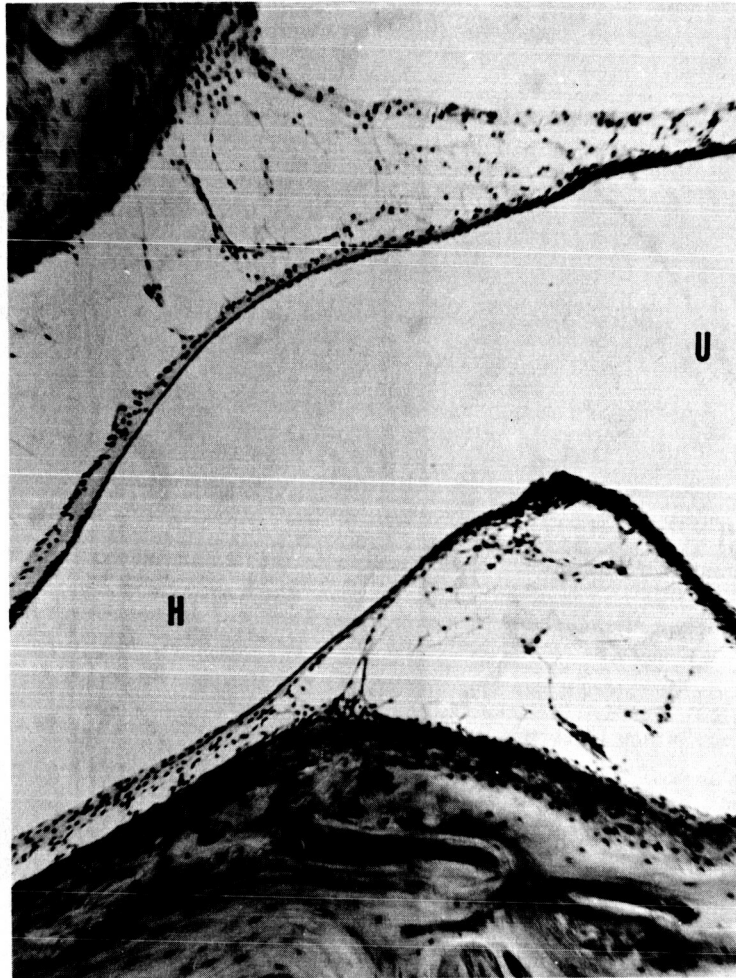


Figure 9

Smooth epithelial thickening at the junction of utricle (U) and posterior crus of horizontal semicircular canal (H) in another squirrel monkey. 100X

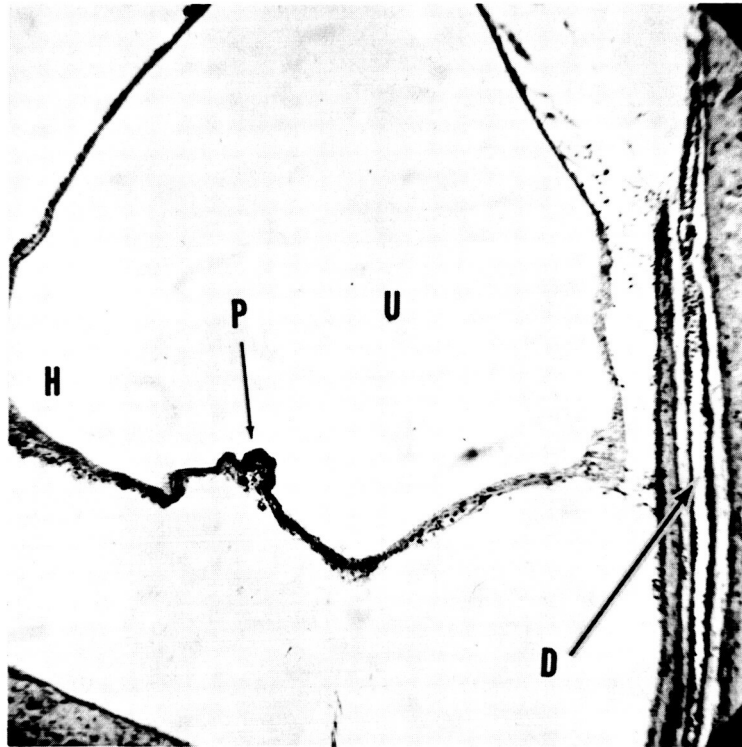


Figure 10

Papillary epithelial mound (P) at the junction of utricle (U) and posterior crus of horizontal semicircular canal (H) in the dog. 90X

D: Endolymphatic duct.

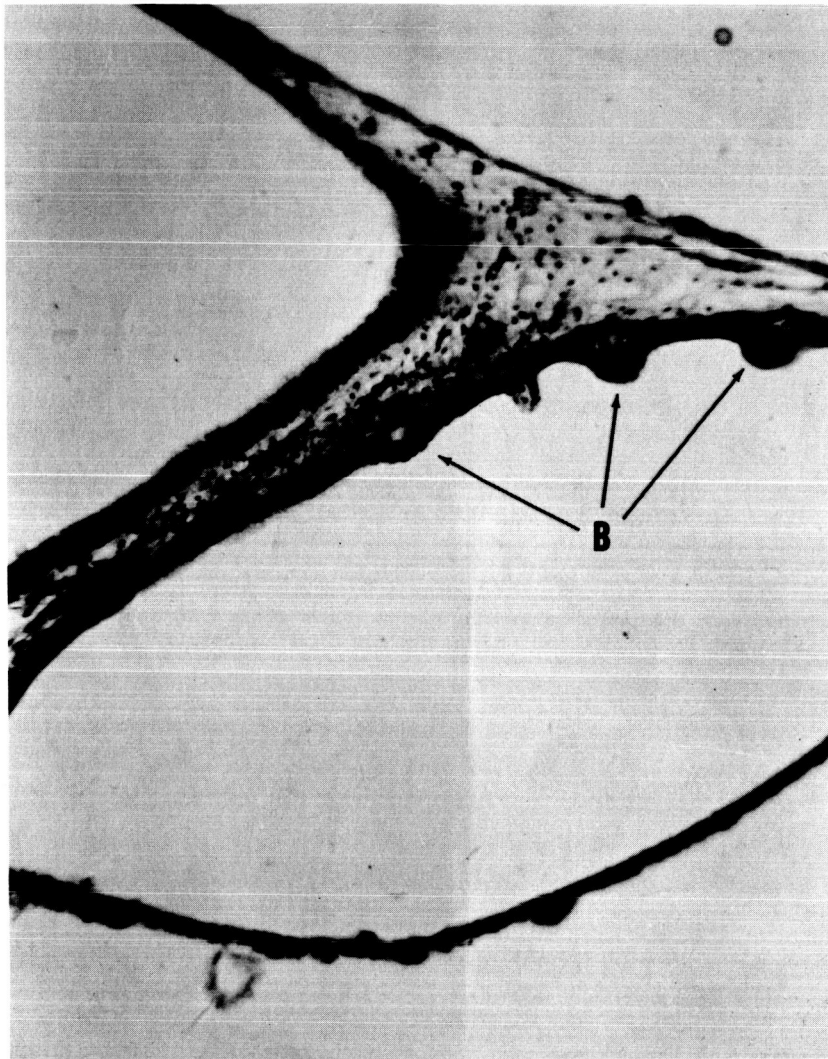


Figure 11

Several bleb formations (B) in the posterior semicircular canal ampulla in a normal human adult. 150X

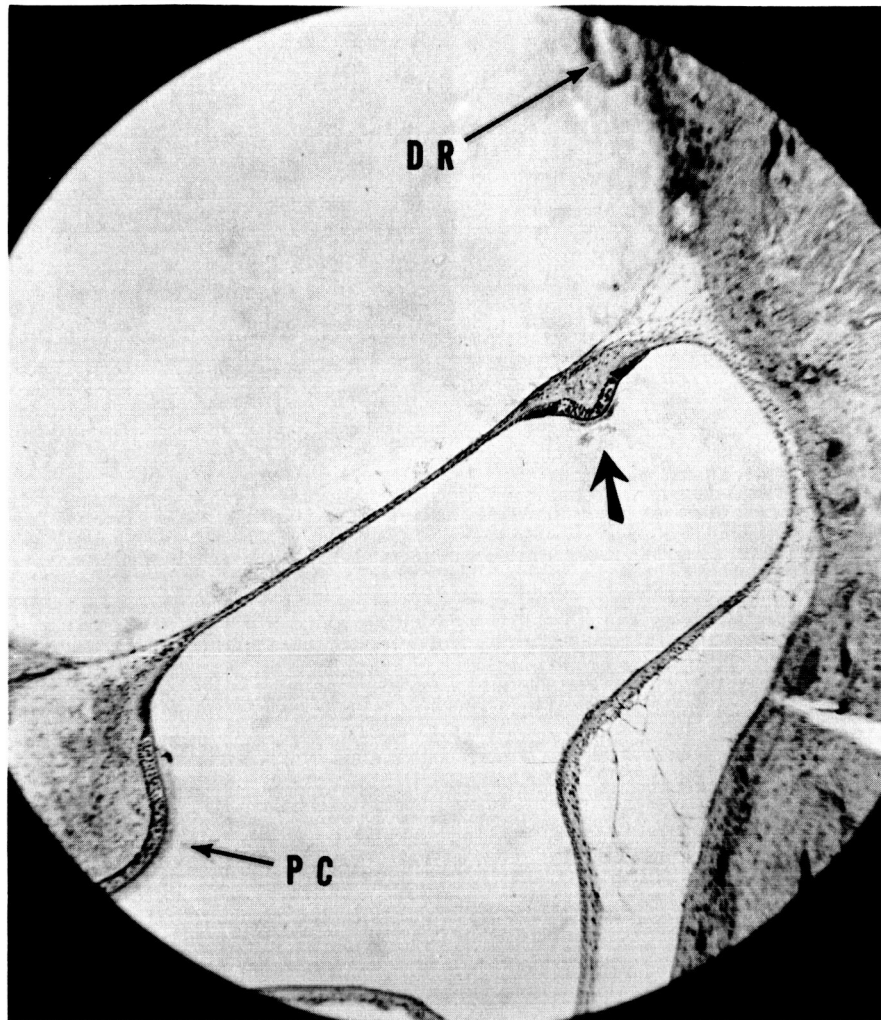


Figure 12

Showing sensura neglecta in the cat (broad arrow). 80X

DR: A part of Ductus reuniens.

PC: Posterior semicircular canal crista.

Note the similarity of the epithelial covering of the posterior canal crista and sensura (or crista) neglecta.

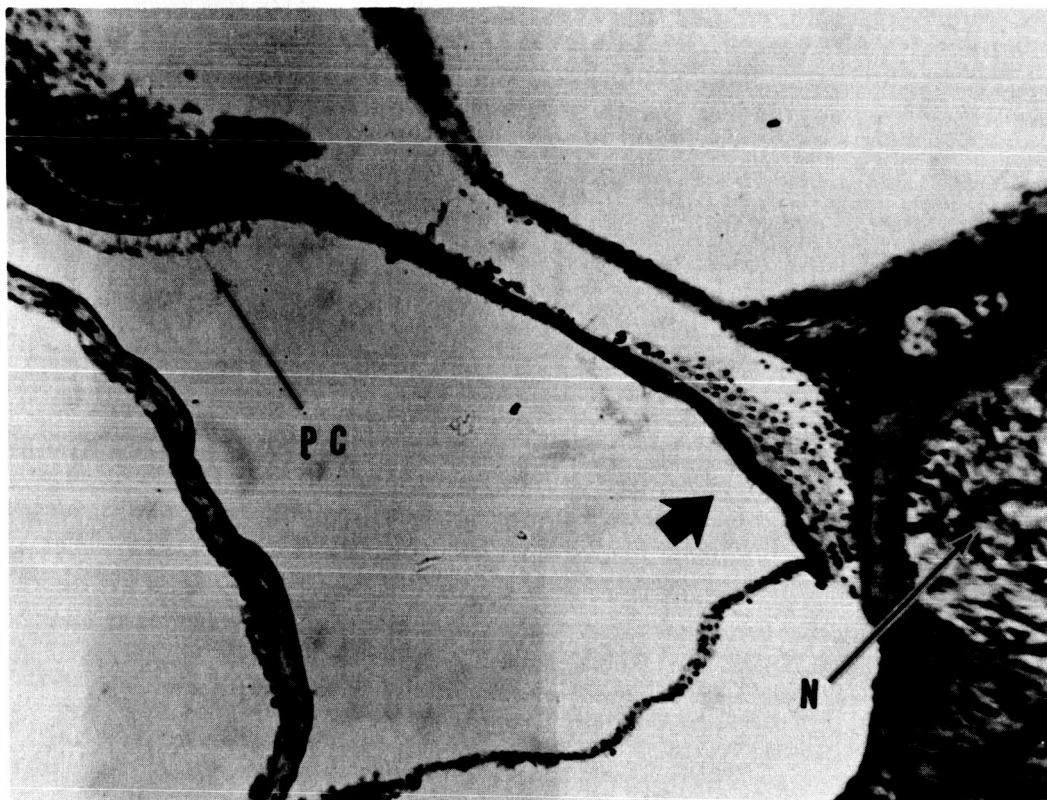


Figure 13

Showing the sensura neglecta (broad arrow) in the dog. 150X

N: Canalis singularis nerve (or posterior ampullar nerve).
PC: Posterior semicircular canal crista.

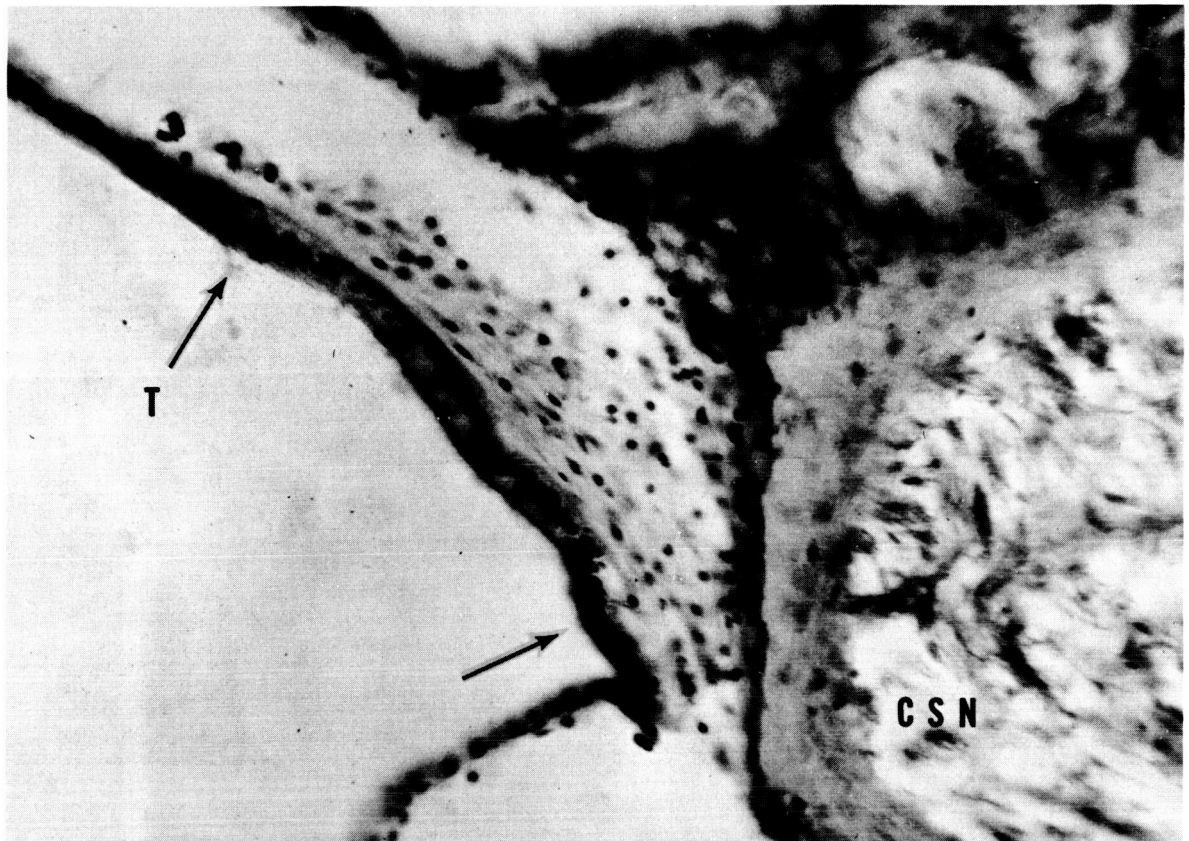


Figure 14

High magnification view of Figure 13. The two arrows are indicating the transitional areas (T) of the sensura (or crista) neglecta (dog). 350X

CSN: Canalis singularis nerve.